Serial No. 09/237,646

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of	:	December 27, 2006
V. Castelli, et al	:	Group Art No.: 2162
Serial No. 09/237,646	:	Examiner: C. Truong
Filed: January 26, 1999	:	for IBM Corporation Anne Vachon Dougherty 3173 Cedar Road Yorktown Heights, NY 10598
Title: METHOD AND APPARATUS FOR SIMILARITY RETRIEVAL FROM ITERATIVE REFINEMENT		

Board of Patent Appeals and Interferences
Alexandria, VA 22313-1450

APPEAL BRIEF (37 CFR 41.37)

Appellants hereby appeal to the Board of Patent Appeals and Interferences from the decision dated April 6, 2006 of the Examiner finally rejecting Claims 1-4, 9-12 and 18 in the above-identified patent application, and respectfully request that the Board of Patent Appeals and

Interferences consider the arguments presented herein and reverse the Examiner's rejection.

I. REAL PARTY IN INTEREST

The appeal is made on behalf of Assignee, International Business Machines Corporation and the inventors, Vittorio Castelli, Chung Sheng Li, and John R. Smith, who are real parties in interest with respect to the subject patent application.

II. RELATED APPEALS AND INTERFERENCES

There are no pending related appeals or interferences with respect to the subject patent application.

A prior Notice of Appeal was filed on October 30, 2003 and an Appeal Brief was filed on December 30, 2003. In response to the Appeal Brief, the Examiner re-opened prosecution, resulting in withdrawal of the Appeal. No decision was rendered by the Board of Patent Appeals and Interferences.

III. STATUS OF CLAIMS

There are nine (9) claims pending in the subject patent application, numbered 1-4, 9-12 and 18. No claims stand allowed. Claims 5-8 and 13-17 were withdrawn from consideration in response to a restriction requirement dated December 1, 2005 (nearly five years after the first Office Action). A complete copy of the claims involved in the appeal is attached hereto.

IV. STATUS OF AMENDMENTS

There are no unentered amendments filed after final rejection for the application.

V. SUMMARY OF INVENTION

The invention which is the subject of the remaining pending claims is a computerized method, apparatus, and program storage device for performing a method for retrieving multidimensional data from a database in response

to a user query. Independent Claims 1, 9 and 18 recite the method, program storage device and system, respectively.

Independent Claim 1

The method for retrieving multidimensional data from a database in response to a user query, as recited in independent Claim 1, includes a first step of searching the database to retrieve data based on the user query (step 201 of Fig. 2, page 10, lines 4-5 and page 17, lines 2-4). Retrieved data is presented to the user and user input based on the retrieved data is received (step 203 of Fig. 2; page 9, lines 16-19; page 10, lines 5-6 and page 16, lines 9-10). The database is then transformed based on the user input to generate a transformed database, wherein the transforming comprises at least one of modifying a linear transform matrix of the database, transforming the feature space of the database, changing distance/similarity measures within the database, and changing weighting features within the database (steps 204-205; page 10, lines 6-8; page 16, lines 5-11; page 17, lines 13-16; page 20, line 2-page 23, line 11; Fig. 6 and page 24, lines 1-8). Once the database has been transformed, the method successively searches the transformed database to retrieve data (page 17, lines 17-

19); and iteratively repeats steps b through e until the query is satisfied (steps 206, 207 and 203-205 of Fig. 2; page 10, line 8 and page 18, lines 3-4).

Independent Claim 9

Claim 9 recites a program storage device (page 33, lines 1-16) for causing a machine to perform the method as recited in independent Claim 1. The method for retrieving multidimensional data from a database in response to a user query, as recited in independent Claim 1, includes a first step of searching the database to retrieve data based on the user query (step 201 of Fig. 2 and page 17, lines 2-4). Retrieved data is presented to the user and user input based on the retrieved data is received (step 203 of Fig. 2; page 9, lines 16-19; page 10, lines 5-6 and page 16, lines 9-10). The database is then transformed based on the user input to generate a transformed database, wherein the transforming comprises at least one of modifying a linear transform matrix of the database, transforming the feature space of the database, changing distance/similarity measures within the database, and changing weighting features within the database (steps 204-205, page 16, lines 5-11, page 17, lines 13-16, page 21, line Fig. 6 and page 24, lines 1-8). Once

the database has been transformed, the method successively searches the transformed database to retrieve data (page 17, lines 17-19); and iteratively repeats steps b through e until the query is satisfied (steps 206, 207 and 203-205 of Fig. 2 and page 18, lines 3-4).

Independent Claim 18

Claim 18 recites a system (106 of Fig. 1 and page 12-line 9 through page 13, line 3) for retrieving multidimensional data from a database in response to a user query. The system comprises a search component for searching the database to retrieve data based on said query (similarity retrieval engine 103 of Fig. 1), a presentation component for presenting retrieved data to user and receiver component for receiving user input (database management system 104 for providing data to the client system 101 and for receiving user feedback), a transformation component for transforming the database based on said user input to generate a transformed database (the spatial indexing engine 107 in association with 108 and 110-112).

VI. GROUND OF REJECTION TO BE REVIEWED

Appellants seek review not only of the present grounds of rejection, but also of the Examiner's decision to issue a restriction requirement after nearly five years of prosecution of the same set of claims, of the "final" status of the most recent Office Action, and of the Examiner's refusal to withdraw the Final Office Action.

The grounds of rejection in the Final Office Action included the following:

-Claims 1-2, 9-10 and 18 have been rejected under 35 USC 102(a) as being anticipated by U.S. Patent 5,963,940 of Liddy, et al (hereinafter "Liddy");

-Claims 1, 9 and 18 have been rejected under 35 USC 102(e) as anticipated by U.S. Patent 5,852,823 of De Bonet (hereinafter "De Bonet");

-Claims 1-2, 9-10 and 18 have been rejected under 35 USC 103(a) as being unpatentable over Liddy in view of U.S. Patent 5,983,237 of Jain (hereinafter "Jain");

-Claims 3-4 and 11-12 have been rejected under 35 USC 103(a) as being unpatentable over Liddy in view of Jain and further in view of U.S. Patent 5,845,278 of Kirsch (hereinafter "Kirsch");

-Claims 3-4 and 11-12 have been rejected under 35 USC 103(a) as being unpatentable over Liddy in view of Kirsch;

-Claims 2 and 10 have been rejected under 35 USC 103(a) as being unpatentable over De Bonet in view of Jain; and

-Claims 3-4 and 11-12 have been rejected under 35 USC 103(a) as being unpatentable over De Bonet in view of Jain and further in view of Kirsch.

VII. ARGUMENT

The restriction requirement

Applicants respectfully assert that the Examiner has made repeated errors in prosecuting the subject application, in spite of Applicants' continued efforts to advance the prosecution of the application. Applicants had submitted six (6) responses to non-final actions between May of 2001 and May of 2003 prior to the filing of a Notice of Appeal in October of 2003. During that time, numerous efforts were made to assist the Examiner in understanding the language of the claims, the teachings of the cited art, and the MPEP standards for generating Office Actions, largely without the

necessity of any claims' amendments since the cited art did not anticipate or obviate the language of the claims. During that time, a Declaration of Prior Invention (attached in the Evidence Appendix) was also filed. After the filing of the Appeal Brief in October of 2003, and pursuant to multiple telephone interviews with Examiner Truong and her then-supervisor Jean Corrielus, the Final Office Action of July 30, 2003 was withdrawn and a new Office Action was generated on March 11, 2004. The newly generated Office Action was erroneously indicated as a Final Office Action and was subsequently withdrawn after yet another telephone interview.

Examiner Truong generated a non-final Office Action on June 22, 2004 citing new grounds for rejection of Claims 1, 2, 9 and 10, indicating that Claims 5-8 were allowed, and indicating that Claims 3, 4, 11 and 12 were allowable. After Applicants filed a response dated September 22, 2004, however, the Examiner next generated a Requirement for Restriction on December 1, 2005...***over five years after the first office action*** and continued prosecution on the same core set of claims. Applicants believe that it was both capricious and retaliatory of the Examiner to generate a Restriction Requirement after five years of prosecution of

the claims in the one application and after indicating allowability of claims drawn to both the method and the apparatus. Applicants also believe that it was unreasonable of the Examiner to allow over 14 months to pass between the receipt of Applicants' Amendment (dated 9/22/2004) and the next Office Action, namely the Requirement for Restriction. Appellants contend that they should not be forced to incur additional filing expenses for prosecution of the withdrawn claims, when those claims have, in fact, been examined repeatedly over the five years preceding the Requirement for Restriction.

Accordingly, Appellants seek to have the status of the withdrawn claims, Claims 5-8 and 13-17, returned to the same status that the claims had prior to June 22, 2004.

Withdrawal of the "final" status of the Office Action

Most recently, the Examiner issued a Final Office Action on April 6, 2006 in response to the Election filed January 3, 2006. Applicants believe that the Examiner erred in issuing the Office Action as a Final Office Action since the "Office Action Summary" of the previous Office Action (dated 6/22/04) had been inconsistent with the conclusions reached in the "Detailed Action" of that action. Although

Applicants had responded to that Action, clarification was required, requested and should have been provided in the form of a non-final action. Applicants believe that the final status of the Office Action was inappropriate.

Appellants further assert that the Final Office Action was flawed as detailed hereinafter. The Examiner had rejected Claims 1-2, 9-10 and 18 under 35 USC 102(e) as anticipated by Liddy (sections 3-4 on pages 4-8 of the Office Action, not including the erroneously-labeled section 4 which begins on page 8 and related to a different ground for rejection). By concluding that Liddy anticipated the claim language, the Examiner necessarily concluded that Liddy taught each and every claim feature. However, the Examiner later stated, in the section labeled 6 on pages 10-14, that Claims 1-2, 9-10 and 18 were rejected under 35 USC 103(a) as being unpatentable over Liddy in view of Jain. The Examiner expressly stated, on page 12 and on page 14 that "Liddy does not explicitly the (*sic*) claimed limitation 'retrieving multidimensional data from a database in response to a user query'". Clearly the Examiner erred in rejecting the claim language as anticipated by Liddy and then acknowledging that Liddy did not teach some of the

claim language. Applicants believe that the flawed Final Office Action should have been withdrawn.

Applicants further note that the Examiner had, in the previous Non-Final Office Action of 6/22/2004, rejected Claims 1, 2, 9 and 10 as unpatentable over Liddy, acknowledging that "Liddy does not explicitly teach the claimed limitation of "repeating step b through e until the results for said query is satisfied by the user". However, in the more recent anticipation rejection, the Examiner reached a conclusion that Liddy anticipated the claim language, which conclusion was, and is, inconsistent with the previous obviousness rejection. Applicants reiterate that the Office Action was flawed and should have been withdrawn.

Appellants bring to the Board's attention the fact that, in response to a Pre-Appeal Brief Request for Review filed with the Notice of Appeal on 7/6/2006, a Pre-Appeal Brief conference was held. Multiple versions of the Notice of Panel Decision from Pre-Appeal Brief Review were generated, with inconsistent status indicated (copies attached in the Evidence Appendix). The undersigned attorney conducted several telephone interviews with

Examiner Truong to clarify the results of the Pre-Appeal Brief Review conference.

It appears that the rejections under 35 USC 102(e) rejecting Claims 1-2, 9-10 and 18 have been withdrawn. However, all of the 35 USC 103 rejections which rely on the Liddy patent as a primary reference, and which rely on the Examiner's interpretation of supposedly anticipatory teachings of the Liddy patent, remain. Appellants' attorney has pointed out to the Examiner that it is both inconsistent and untenable to withdraw the rejections and yet maintain reliance on the conclusions found in those rejections.

Appellants' attorney suggested to Examiner Truong that the appropriate result of the Pre-Appeal Brief Review conference should have been withdrawal of the Final Office Action and re-opening of the prosecution of the application. The recommended action, however, has not been taken. As a part of the Appeal, therefore, Appellants request review of the appended Notice of Panel Decision from Pre-Appeal Brief Review. While Appellants ultimately seek reversal of all of the Examiner's rejections, Appellants believe that the Examiner's actions in response to the Pre-Appeal Brief Request for Review and throughout the course of prosecution of the subject application have forced Appellants to expend

considerable amounts on unnecessary filing fees and to incur considerable preparation fees. Accordingly, Appellants seek review of the prosecution history of the application to determine not only the patentability of Claims 1-15 but also to determine whether Appellants should be entitled to reimbursement of filing fees.

Claims 1, 9 and 18

35 USC 102(e) rejection as anticipated by Liddy

Independent Claims 1, 9 and 18, as well as dependent claims 2 and 10, were rejected under 35 USC 102(e) as being anticipated by Liddy. While these rejections may have been withdrawn, Appellants will address the Examiner's application of the Liddy teachings to the claim language, since the Examiner's conclusions with respect to Liddy are relied upon in subsequent rejections discussed below.

The Liddy patent is directed to a system and method wherein a GUI allows a user to "interact with the computer-generated query representation" (Col. 7, lines 35-45) and to "re-submit a query based on the contents of documents considered highly relevant" (Col. 27, lines 10-25). Liddy accepts "natural language" input from a user, interprets the

natural language input to correlate it to search terms used to categorize documents in a document database and thereby generate a usable search query representation, and then shows the generated search query representation to the user. The user may edit the generated search query representation if it is not what the user meant. Thereafter, the Liddy system searches the document database using the generated search query representation. Liddy retrieves documents which are most relevant to the search query and presents the list of documents to the user. The user may then select documents for viewing. If the user is dissatisfied with the query results, the process is restarted with a new natural language query. In detailing what is meant by re-submitting the query, Liddy teaches at Col. 35, lines 25-35 that a user may mark relevant documents (with such system-provided designations as "more like") after which the system can generate a new query representation.

Appellants respectfully assert that Liddy does not anticipate the invention as claimed. It is first to be noted that Liddy provides searching of a document database, while the present invention provides retrieval of multidimensional data from a database. Liddy generates query representations using the fixed word search indexes

that are used to classify documents in the document database. The present application explains that the indexing of multidimensional data in a database, and the retrieval of multidimensional data from a database, is significantly more complex than indexing and retrieving documents in a document database. Multidimensional data should be indexed not only according to fixed word search type of indexes, as would be used for documents in a document database, but also along various other content and context measures or characterizations (e.g., temporal indexing, spatial indexing, etc) and relationships (e.g., semantics). Under the present invention, retrieval of multidimensional data is facilitated by dynamically transforming the database in response to a user's query. Liddy does not teach or suggest the indexing or searching of a multidimensional database or the transforming of a database in response to a user query.

With reference to the first feature of independent method Claim 1, which parallels the language of the other independent claims, Appellants acknowledge that Liddy searches a database to retrieve data in response to a user query. Liddy does not, however, search a multidimensional database in response to a user query.

With regard to the claim feature of presenting retrieved data to a user, Appellants acknowledge that Liddy presents a list of documents to a user. Liddy does not, however, present retrieved multidimensional data to a user.

With regard to the claim feature of receiving user input based on the retrieved data, Appellants acknowledge that Liddy accepts user input, since the Liddy user can mark documents as "most like" what they were searching for "which causes the query representation to be modified in view of the documents and the refined query to be rerun" (Col. 28, lines 37-40). As above, Appellants maintain that Liddy does not perform the foregoing in the context of multidimensional data.

The Liddy patent does not teach or suggest the claim feature of transforming a database based on user input to generate a transformed database. The Examiner notes that Liddy's "matcher determines the similarity between query and documents" and then concludes that the "above information shows that each document is converted by changing similarity measure of each document". Appellants respectfully disagree. Determining a similarity measure between a document and a query does not result in any change to the document. Liddy does not change the document and does not

change the document database. Accordingly, it cannot be concluded that Liddy teaches or suggests transforming the database.

The Examiner further concludes that "the transforming of each document comprises changing distance/similarity measure with the document for the refined query or each time user's input" *(sic)*. Appellants again contend that computing a new similarity measure does not results in any change to the document or the document database.

With regard to the claim feature of successively searching the transformed database to retrieve data, Appellants note that the Examiner cites the claim feature as "successively searching the transformed database to ***retrieved*** data" (emphasis added). The incorrect word may be the result of a typographical error; however, Appellants bring the error to the attention of the Board since such an error in understanding the claim term may contribute to the Examiner's misinterpretation of the claim feature. The Examiner states that Liddy's matcher output "is a ranked list of documents assigned to folder and the rank position of a document with each folder is determined by a similarity score computed in DR-Link matcher." Steps of retrieving

documents and ranking them by similarity score do not teach or suggest successively searching a transformed database.

Finally, with regard to the claim feature of repeating steps b through e until the results satisfy the query, the Examiner points to the Liddy process flow illustrated in Figs. 9A and 9B which shows that a, if a user selects the "refine query" option and marks documents for relevance feedback, the Liddy system will begin a new search. Appellants contend, however, that Liddy is not repeating steps of presenting retrieved multidimensional data to a user, receiving user input based on the retrieved multidimensional data, transforming the database based on user input to generate a transformed database and successively searching the transformed database.

Anticipation under 35 USC 102 is established only when a single prior art reference discloses each and every element of a claimed invention. See: In re Schreiber, 128 F. 3d 1473, 1477, 44 USPQ2d 1429, 1431 (Fed. Cir. 1997); In re Paulsen, 30 F. 3d 1475, 1478-1479, 31 USPQ2d 1671, 1673 (Fed. Cir. 1994); In re Spada, 911 F. 2d 705, 708, 15 USPQ2d 1655, 1657 (Fed. Cir. 1990) and RCA Corp. v. Applied Digital Data Sys., Inc., 730 F. 2d 1440, 1444, 221 USPQ 385, 388 (Fed. Cir. 1984). Since the Liddy patent does not teach

means or steps for retrieving multidimensional data from a database in response to a user query including steps and means for receiving user input based on retrieved multidimensional data and transforming the database based on the user input to generate a transformed database, it cannot be maintained that Liddy anticipates the invention as claimed in the independent Claims 1, 9 and 18.

Claims 1, 9 and 19

35 USC 102(e) rejection as anticipated by De Bonet

Independent Claims 1, 9 and 18, as well as dependent claims 2 and 10, were rejected under 35 USC 102(e) as being anticipated by De Bonet.

Appellants point out the error on page 8 of the Office action noting that the Examiner stated "[a]s to claims 1 and 9, Liddy teaches the claimed limitations:" instead of stating "De Bonet teaches the claimed limitations". In spite of the error, Appellants address the rejections as if directed to De Bonet

The De Bonet patent is directed to a system and method for image retrieval. Under De Bonet, images in an image database are indexed by image "signatures" which are generated by iterative multi-level convolution filtering of

pixel values for each color axis of the image (Col. 6, lines 12-16). When a query is to be conducted, the user supplies a group of so-called query images in which each image is structurally similar to the images that the user wants to find (Col. 6, lines 1-4). The system computes a signature for each query image (Col. 13, lines 20-24) and computes average variance vectors for the query image signatures (Col. 13, lines 27-28). Thereafter, the system compares the query image signature information to image information for successive "test" images and produces similarity measures for each test image in the database (Col. 13, line 45 through Col. 14, line 19). The test images are ranked by descending similarity measure (Col. 14, lines 19-22) and after all images in the image database have been processed, the images with the highest similarity measures are displayed to the user (Col. 14, lines 24-36). De Bonet also teaches that a user may provide a textual description of an image that is to be stored by the system. The textual description may be stored with the image signature and the user may specify a textual query rather than an image query (Col. 22, lines 40-48).

Appellants respectfully assert that De Bonet does not anticipate the invention as claimed.

With reference to the first feature of independent method Claim 1, which parallels the language of the other independent claims, Appellants acknowledge that De Bonet searches a database to retrieve data in response to a user query. De Bonet does not, however, search a multidimensional database in response to a user query.

With regard to the claim feature of presenting retrieved data to a user, Appellants acknowledge that De Bonet presents retrieval results (i.e., images or image pointers) to a user. De Bonet does not, however, present retrieved multidimensional data to a user.

With regard to the claim feature of receiving user input based on the retrieved data, the Examiner has cited the teachings found in Col. 22 of De Bonet. De Bonet teaches that a user may input a textual query, "preview the query image(s)" retrieved by the system in response to the textual query and then select some of the retrieved images to serve as query images. As above, Appellants maintain that De Bonet does not perform the foregoing in the context of multidimensional data.

The De Bonet patent does not teach or suggest the claim feature of transforming a database based on user input to generate a transformed database. The Examiner cites the De

Bonet teachings (Col. 22, line 60-Col. 23, line 7) related to comparing image vectors to yield similarity measures. However, generating similarity measures is not the same as or suggestive of transforming a database. The Examiner also cites the teachings at Col. 12, lines 55-60 in which De Bonet teaches precomputing signatures for test images. Precomputing a signature for a stored image is not transforming the database. Even in the De Bonet embodiment where signatures are not precomputed but are computed as each "test" image is considered, the image database is not being transformed. The Examiner also cites the teachings found in Col. 13, lines 15-45 which discuss computing signatures for query images, computing vectors and sending the information to the comparison engine. Nothing in the cited passages teaches or suggests transforming a database. As noted above, determining a similarity measure between stored data and a query does not result in any change to the stored data. De Bonet does not change the image and does not change the image database. Accordingly, it cannot be concluded that De Bonet teaches or suggests means or steps for transforming the database.

With regard to the claim feature of successively searching the transformed database to retrieve data,

Appellants note that the Examiner again cites the claim feature as "successively searching the transformed database to ***retrieved*** data" (emphasis added). The Examiner cites the passage from Col. 23, lines 1-15 which teaches that a user may refine his/her textual query "to engender additional or substitute query images, for preview, and associated signatures for subsequent use during image retrieval." Modifying a query to send to the same database does not result in successive searching of a transformed database.

Finally, with regard to the claim feature of repeating steps b through e until the results satisfy the query, the Examiner points to the same De Bonet teachings from Col. 23, lines 1-15 discussed in the preceding paragraph. The cited passage teaches that the user can modify the textual query to pull up different query images. The passage does not teach or suggest repeating steps of presenting retrieved multidimensional data to a user, receiving user input based on the retrieved multidimensional data, transforming the database based on user input to generate a transformed database and successively searching the transformed database. The Examiner additionally cites the passage found in Col. 15, lines 1-7 which teaches that the user can instruct the image retrieval and display manager to use any

retrieved image as an additional query image in order to refine the subsequent retrieval operation for that query. Selecting an image to serve as a query image for searching a fixed image database does not anticipate the repeating of presenting retrieved multidimensional data to a user, receiving user input based on the retrieved multidimensional data, transforming the database based on user input to generate a transformed database and successively searching the transformed database.

Anticipation under 35 USC 102 is established only when a single prior art reference discloses each and every element of a claimed invention. See: In re Schreiber, 128 F. 3d 1473, 1477, 44 USPQ2d 1429, 1431 (Fed. Cir. 1997); In re Paulsen, 30 F. 3d 1475, 1478-1479, 31 USPQ2d 1671, 1673 (Fed. Cir. 1994); In re Spada, 911 F. 2d 705, 708, 15 USPQ2d 1655, 1657 (Fed. Cir. 1990) and RCA Corp. v. Applied Digital Data Sys., Inc., 730 F. 2d 1440, 1444, 221 USPQ 385, 388 (Fed. Cir. 1984). Since the De Bonet patent does not teach means or steps for retrieving multidimensional data from a database in response to a user query including steps and means for receiving user input based on retrieved multidimensional data and transforming the database based on the user input to generate a transformed database, it cannot

be maintained that De Bonet anticipates the invention as claimed in the independent Claims 1, 9 and 18.

Claims 1, 9 and 18

35 USC 103(a) as unpatentable over Liddy in view of Jain

Independent Claims 1, 9 and 18 have also been rejected as unpatentable over Liddy in view of Jain. Appellants rely on the arguments presented above with respect to the teachings of the Liddy patent. The Examiner has stated on page 12 that "Liddy does not explicitly the *(sic)* claimed limitation 'retrieving multidimensional data from a database in response to a user query'." The Examiner cites the Jain patent as teachings retrieving image as multidimensional data from a database in response to a user query and cites Col. 4, lines 30-55 of Jain. The cited passage teaches that Jain stores a set of feature vectors for stored images. Appellants contend that, even if one were motivated to store images with feature vectors in the Liddy system, one would not arrive at the invention as claimed. Neither Liddy nor Jain provides any teaching of means or steps for effecting transformation of a database based on user input to generate

a transformed database and then successive searching of the transformed database.

It is well established under U.S. Patent Law that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention when there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art (*In re Fine,* 837 F. 2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones,* 958 F. 2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992)). Applicants respectfully assert that there are no teachings, suggestions, or motivations provide by the Liddy patent or the Jain patent to modify the Liddy system in such a way as to obviate the invention as claimed. Neither reference teaches or suggests transforming its database as claimed; neither teaches or suggests searching a transformed database; and, neither teaches or suggests iteratively repeating the steps of receiving user input to retrieved results, transforming the database, and successively searching the transformed database until a user query is satisfied.

For a determination of obviousness, the prior art must teach or suggest all of the claim limitations. "All words

in a claim must be considered in judging the patentability of that claim against the prior art" (*In re Wilson,* 424 F. 2d 1382, 1385, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970). If the cited references fail to teach each and every one of the claim limitations, a *prima facie* case of obviousness has not been established by the Examiner. Accordingly, Appellants conclude that the Examiner has not established a *prima facie* case of obviousness against the language of Claims 1, 9 and 18.

Claims 2 and 10

35 USC 103(a) as unpatentable over Liddy in view of Jain

Claims 2 and 10 have also been rejected as unpatentable over Liddy in view of Jain. Claims 2 and 10 depend from Claims 1 and 9 respectively and recite method and program storage device, respectively, wherein the method further comprises reformulating the query based on said user input and wherein said searching said transformed database comprises searching said transformed database based on said reformulated query. The Examiner cites the Liddy patent teachings from Col. 28, lines 30-40 regarding user input to change the folders in which retrieved documents are stored

and to mark documents using the "most like" designation. While Liddy does accept user input, and may use the "most like" designation in a subsequent query, Liddy is not providing a reformulated query to search a transformed database, as is claimed by Claims 2 and 10. The cited passage from Col. 21, lines 25-67 details the operations of Liddy's matcher which compares database documents to the query. There is nothing in the description of the matcher which teaches or suggests reformulating a query and searching a transformed database with a reformulated query. Finally, the Examiner cites the passage on computing similarity measures from Col. 22, lines 1-35. Appellants reiterate that computing similarity measures does not result in transformation of the stored documents or of the document database.

Applicants reiterate that, for a determination of obviousness, the prior art must teach or suggest all of the claim limitations (*In re Wilson,* 424 F. 2d 1382, 1385, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970). If the cited references fail to teach each and every one of the claim limitations, a *prima facie* case of obviousness has not been established by the Examiner. Accordingly, Appellants conclude that the Examiner has not established a *prima facie* case of

obviousness against the language of Claims 2 and 10 using a combination of teachings from Liddy and Jain.

Claims 2 and 10

35 USC 103(a) as unpatentable over De Bonet in view of Jain

Claims 2 and 10 have also been rejected as unpatentable over De Bonet in view of Jain. Applicants rely on the discussion of the De Bonet patent provided above. In rejecting Claims 2 and 10, the Examiner states that "De teaches the claimed limitation 'reformulating the query based on user input and wherein said searching said transformed database comprises searching said transformed database based on said reformulated query". The Examiner does not provide citation to any of the De Bonet patent teachings in reaching that conclusion. The Federal Circuit has stated that when patentability turns on the question of obviousness, the obviousness determination "must be based on objective evidence of record" and that "this precedent has been reinforced in myriad decisions, and cannot be dispensed with." (In re Lee, 277 F. 3d 1338, 1343 (Fed. Cir. 2002)). Moreover, the Federal Circuit has stated that "conclusory statements" by an examiner fail to adequately address the factual question of motivation, which is material to

patentability and cannot be resolved "on subjective belief and unknown authority" (Id. at 1343-1344). Accordingly , Applicants believe that the Examiner erred in concluding that De Bonet teaches the claimed limitation without providing any supporting teachings from De Bonet.

The Examiner further states that "Jain teaches sends *(sic)* refinement parameters based on user input to a query refinement for modification of a query". The Examiner further states that "[t]he query refinement processor may send a new query structure for refinement of the database query to query processor to produce a new set of query results (col. 4, lines 42-48)". Jain does teach refinement of a query; however, there is nothing in the cited passage which teaches or suggests searching a transformed database with a reformulated query. Applicants reiterate that, for a determination of obviousness, the prior art must teach or suggest all of the claim limitations (*In re Wilson,* 424 F. 2d 1382, 1385, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970). Accordingly, Appellants conclude that the Examiner has not established a *prima facie* case of obviousness against the language of Claims 2 and 10 using a combination of teachings from De Bonet and Jain.

Claims 3-4 and 11-12

35 USC 103(a) as being unpatentable over Liddy in view of Jain and further in view of Kirsch

Appellants rely on the discussions of the Liddy and Jain patents provide above. With regard to Claims 3 and 11, the Examiner has concluded that "Liddy does not explicitly teach the claimed limitation 'extracting indices from said database and wherein said searching is preceded by retrieving indices to focus said search on indexed information in said database'." With regard to Claims 4 and 12, the Examiner states that "Liddy does not explicitly teach the claimed limitation 'applying said extracted indexes *(sic)* to said transformed database'."

The Kirsch patent teaches that individual collection indexes can be transmitted over the internet to a meta index processor. The Kirsch patent does not extract the indexes from the database to be searched. Accordingly, Appellants contend that the Examiner erred in concluding that Kirsch teaches the limitation set forth in Claims 3 and 11. Further, Kirsch does not apply the extracted indexes to the same database from which it extracted the indexes, nor does Kirsch teach or suggest applying indexes to a transformed

database, as is expressly recited in Claims 4 and 12. Appellants further aver that the dependent claims include all of the limitations of the claims from which they depend, as well as the limitations of any intervening claims. Since none of the cited references teach all of the limitations of the independent claims, then clearly obviousness has not been established against the claims which depend therefrom.

For a determination of obviousness, the prior art must teach or suggest all of the claim limitations. "All words in a claim must be considered in judging the patentability of that claim against the prior art" (*In re Wilson,* 424 F. 2d 1382, 1385, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970). Since the combined references fail to teach each and every one of the claim limitations, a *prima facie* case of obviousness has not been established by the Examiner.

Claims 3-4 and 11-12

35 USC 103(a) as being unpatentable over Liddy in view of Kirsch

Applicants rely on the discussion presented above with regard to the teachings of Kirsch as applied to a

combination of Liddy and Jain in response to the rejection of Claims 3, 4, 11 and 12.

Since the anticipation rejection of the independent claims, Claims 1 and 9, from which the Claims 3-4 and 11-12 respectively depend, has been withdrawn, Applicants believe that this rejection should have been withdrawn as well.

Claims 3-4 and 11-12

35 USC 103(a) as being unpatentable over De Bonet in view of Jain and further in view of Kirsch

Appellants rely on the arguments set forth above with regard to the teachings of the De Bonet, Jain and Kirsch patents. Appellants respectfully conclude that the Examiner has not established a *prima facie* case of obviousness against the Claim 3, 4, 11 and 12 since none of the De Bonet, Jain or Kirsch patents teaches the claimed steps and means for extracting indices and applying extracted indices to a transformed database, including all of the limitations of the claims from which they respectively depend.

CONCLUSION

Appellants respectfully assert that the Examiner has erred in issuing a Restriction Requirement after five years of prosecution; has erred in issuing a Final Office Action at this juncture in the prosecution; has erred in not withdrawing the Final Office Action based on the conclusions of the Pre-Appeal Brief Review; and has erred in rejecting Claims 1-4, 9-12 and 18. Appellants request that the decisions of the Examiner be overturned by the Board and that the claims be passed to issuance.

Respectfully submitted,
V. Castelli, et al

By: Anne Vachon Dougherty
Anne Vachon Dougherty
Registration No. 30,374
Tel. (914) 962-5910

APPENDIX OF CLAIMS

1. A computerized method for retrieving multidimensional data from a database in response to a user query, comprising the steps of:

a. first searching said database to retrieve data based on said query;

b. presenting retrieved data to user;

c.receiving user input based on said retrieved data;

d.transforming said database based on said user input to generate a transformed database, wherein said transforming comprises at least one of modifying a linear transform matrix of the database, transforming the feature space of the database, changing distance/similarity measures within said database, and changing weighting features within said database;

e.successively searching said transformed database to retrieve data; and

f. repeating steps b through e until the results for the said query is satisfied.

2. The method of Claim 1 wherein said step of transforming said database further comprises reformulating the query

based on said user input and wherein said searching said transformed database comprises searching said transformed database based on said reformulated query.

3. The method of Claim 1 further comprising extracting indices from said database and wherein said searching is preceded by retrieving indices to focus said search on indexed information in said database.

4. The method of Claim 3 wherein said successively searching transformed database comprises applying said extracted indices to said transformed database.

5.(withdrawn) Apparatus for performing retrieval of information in response to a user query in a system having at least one client location and at least one server location comprising:

a. at least one database storing said information at said at least one server;

b. a multidimensional indexing engine at said at least one server for maintaining indices related to information in said at least one database and for retrieving said indices in response to said query;

c. a similarity query engine at said server for conducting searches of said at least one database in response to a query;

wherein said similarity query engine receives information regarding said retrieved indices from said multidimensional indexing engine for identifying database areas to be searched.

6.(withdrawn) The apparatus of Claim 5 further comprising means for displaying retrieved information at said client location and for receiving user input regarding said retrieved information.

7.(withdrawn) The apparatus of Claim 6 wherein said multidimensional indexing engine is adapted to refine said indices based on said user input.

8.(withdrawn) The apparatus of Claim 6 wherein each of said at least one server location additionally comprises processor means for reformulating said query based on said user input.

9. A program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for retrieving multidimensional data from a database in response to a user query, said method steps comprising:

a. first searching said database to retrieve data based on said query;

b. presenting retrieved data to user;

c. receiving user input based on said retrieved data;

d. transforming said database based on said user input to generate a transformed database, wherein said transforming comprises at least one of modifying a linear transform matrix of said database, transforming the database feature space, changing distance/similarity measures within said database, and changing weighting features within said database;;

e. successively searching said transformed database to retrieve data; and

f. repeating steps b through e until said query is satisfied.

10. The device of Claim 9 wherein said method step of transforming said database further comprises reformulating

the query based on said user input and wherein said searching said transformed database comprises searching said transformed database based on said reformulated query.

11. The device of Claim 9 wherein said method further comprises extracting indices from said database and wherein said searching is preceded by retrieving indices to focus said search on indexed information in said database.

12. The device of Claim 11 wherein said successively searching transformed database comprises applying said extracted indices to said transformed database.

13.(withdrawn) A method for performing retrieval of information in response to a user query in a system having at least one client location and at least one server location comprising the steps of:

a. storing information in at least one database at said at least one server;

b. maintaining indices related to information in said at least one database;

c. receiving a query;

d. retrieving said indices in response to said query;

e. identifying database areas to be searched based on said retrieved indices; and

f. conducting searches of said at least one database of said areas to be searched in response to said query.

14.(withdrawn) The method of Claim 13 further comprising displaying retrieved information at said client location and receiving user input regarding said retrieved information.

15.(withdrawn) The method of Claim 14 further comprising refining said indices based on said user input.

16. (withdrawn) The method of Claim 13 further comprising reformulating said query based on said user input.

17.(withdrawn) A program storage device, readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for retrieval of information in response to a user query in a system having at least one client location and at least one server location, said method comprising the steps of:

a. storing information in at least one database at said at least one server;

b. maintaining indices related to information in said at least one database;

c. receiving a query;

d. retrieving said indices in response to said query;

e. identifying database areas to be searched based on said retrieved indices; and

f. conducting searches of said at least one database of said areas to be searched in response to said query.

18. A system for retrieving multidimensional data from a database in response to a user query, comprising:

a. a search component for searching said database to retrieve data based on said query;

b. a presentation component for presenting retrieved data to user;

c.a receiver component for receiving user input based on said retrieved data;

d.a transformation component for transforming said database based on said user input to generate a transformed database, wherein said transforming comprises at least one of modifying a linear transform matrix of the database, transforming the feature space of the database, changing

distance/similarity measures within said database, and changing weighting features within said database,

wherein said system successively searches said transformed database to retrieve data and present retrieved data to the user until the query is satisfied.

EVIDENCE APPENDIX

Appellants submit herewith:

- Copies of three Notices of Panel Decision from Pre-Appeal Brief Review generated for this application.

- A Declaration of Prior Invention was submitted by Applicants on February 21, 2002. A copy of the Declaration of Prior Invention is provided herewith. The Declaration of Prior Invention is provided for the information of the Board, but is not relied upon in the arguments presented herein.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/237,646	1999	VITTORIO CASTELLI	YO998-220	7219

EXAMINER
TRUONG, CAM Y T

ART UNIT	PAPER NUMBER
2162	

7590 10/27/2006

ANNE VACHON DOUGHERTY
3173 CEDAR ROD
YORKTOWN HEIGHTS, NY 10598

DATE MAILED: 10/27/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	09/237,646	CASTELLI ET AL.	
	John Breene	Art Unit 2162	

Document Code - AP.PRE.DEC

Notice of Panel Decision from Pre-Appeal Brief Review

This is in response to the Pre-Appeal Brief Request for Review filed 7/6/06.

1. ☐ **Improper Request** – The Request is improper and a conference will not be held for the following reason(s):

   ☐ The Notice of Appeal has not been filed concurrent with the Pre-Appeal Brief Request.
   ☐ The request does not include reasons why a review is appropriate.
   ☐ A proposed amendment is included with the Pre-Appeal Brief request.
   ☐ Other:

The time period for filing a response continues to run from the receipt date of the Notice of Appeal or from the mail date of the last Office communication, if no Notice of Appeal has been received.

2. ☒ **Proceed to Board of Patent Appeals and Interferences** – A Pre-Appeal Brief conference has been held. The application remains under appeal because there is at least one actual issue for appeal. Applicant is required to submit an appeal brief in accordance with 37 CFR 41.37. The time period for filing an appeal brief will be reset to be one month from mailing this decision, or the balance of the two-month time period running from the receipt of the notice of appeal, whichever is greater. Further, the time period for filing of the appeal brief is extendible under 37 CFR 1.136 based upon the mail date of this decision or the receipt date of the notice of appeal, as applicable.

   ☒ The panel has determined the status of the claim(s) is as follows:
   Claim(s) allowed: _____.
   Claim(s) objected to: _____.
   Claim(s) rejected: _____.
   Claim(s) withdrawn from consideration: _____.

3. ☐ **Allowable application** – A conference has been held. The rejection is withdrawn and a Notice of Allowance will be mailed. Prosecution on the merits remains closed. No further action is required by applicant at this time.

4. ☐ **Reopen Prosecution** – A conference has been held. The rejection is withdrawn and a new Office action will be mailed. No further action is required by applicant at this time.

All participants:

(1) *John Breene, SPE.* John E. Breene (3) *Cam Truong, Examiner.*

(2) *Joe Dixon, USPTO.* (4) _____.

Part of Paper No. 200608

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/237,646	01/26/1999	VITTORIO CASTELLI	YO998-220	7219

7590 10/23/2006

ANNE VACHON DOUGHERTY
3173 CEDAR ROD
YORKTOWN HEIGHTS, NY 10598

EXAMINER	
TRUONG, CAM Y T	

ART UNIT	PAPER NUMBER
2162	

DATE MAILED: 10/23/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination
	09/237,646	CASTELLI ET AL.
	John Breene	Art Unit 2162

Document Code - AP.PRE.DEC

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☐ Other:

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☒ The panel has determined the status of the claim(s) is as follows:
Claim(s) allowed: ____.
Claim(s) objected to: ____.
Claim(s) rejected: 1-4, 9-12 and 18.
Claim(s) withdrawn from consideration: ____.

3. ☐ **Allowable application** – A conference has been held. The rejection is withdrawn and a Notice of Allowance will be mailed. Prosecution on the merits remains closed. No further action is required by applicant at this time.

4. ☐ **Reopen Prosecution** – A conference has been held. The rejection is withdrawn and a new Office action will be mailed. No further action is required by applicant at this time.

All participants:

(1) John Breene, SPE. John E. Breene

(2) Joe Dixon, USPTO.

(3) Cam Truong, Examiner.

(4) ____.

Part of Paper No: 20060814

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/237,646		VITTORIO CASTELLI	YO998-220	7219

EXAMINER	
TRUONG, CAM Y T	

ART UNIT	PAPER NUMBER
2162	

DATE MAILED: 09/28/2006

7590 09/28/2006

ANNE VACHON DOUGHERTY
3173 CEDAR ROD
YORKTOWN HEIGHTS, NY 10598

Please find below and/or attached an Office communication concerning this application or proceeding.

Interview Summary

Application No.	Applicant(s)	
09/237,646	CASTELLI ET AL.	
Examiner	**Art Unit**	
Cam Y T. Truong	2162	

All participants (applicant, applicant's representative, PTO personnel):

(1) *Cam Y T. Truong*. (3)_____.

(2) *Anne Vachon Dougherty (Attorney)*. (4)_____.

Date of Interview: *21 September 2006*.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☐ No.
If Yes, brief description: _____.

Claim(s) discussed: _____.

Identification of prior art discussed: _____.

Agreement with respect to the claims f)☐ was reached. g)☒ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *Examiner confirmed with applicant's representative that 102 rejection in view of Liddy was withdrawn based on the pre-appeal conference request and Examiner will not send out any office action. Applicant should file RCE or an Appeal Brief*.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN A NON-EXTENDABLE PERIOD OF THE LONGER OF ONE MONTH OR THIRTY DAYS FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

Cam Y T. Truong

Examiner's signature, if required

Examiner Note: You must sign this form unless it is an Attachment to a signed Office action.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/237,646	01/26/1999	VITTORIO CASTELLI	YO998-220	7219

7590 08/18/2006

ANNE VACHON DOUGHERTY
3173 CEDAR ROD
YORKTOWN HEIGHTS, NY 10598

EXAMINER	
TRUONG, CAM Y T	

ART UNIT	PAPER NUMBER
2162	

DATE MAILED: 08/18/2006

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Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	09/237,646	CASTELLI ET AL.	
		Art Unit	
	John Breene	2162	

Notice of Panel Decision from Pre-Appeal Brief Review

This is in response to the Pre-Appeal Brief Request for Review filed 7/6/06.

1. ☐ **Improper Request** – The Request is improper and a conference will not be held for the following reason(s):

   ☐ The Notice of Appeal has not been filed concurrent with the Pre-Appeal Brief Request.
   ☐ The request does not include reasons why a review is appropriate.
   ☐ A proposed amendment is included with the Pre-Appeal Brief request.
   ☐ Other:

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2. ☐ **Proceed to Board of Patent Appeals and Interferences** – A Pre-Appeal Brief conference has been held. The application remains under appeal because there is at least one actual issue for appeal. Applicant is required to submit an appeal brief in accordance with 37 CFR 41.37. The time period for filing an appeal brief will be reset to be one month from mailing this decision, or the balance of the two-month time period running from the receipt of the notice of appeal, whichever is greater. Further, the time period for filing of the appeal brief is extendible under 37 CFR 1.136 based upon the mail date of this decision or the receipt date of the notice of appeal, as applicable.

   ☒ The panel has determined the status of the claim(s) is as follows:
   Claim(s) allowed: ______.
   Claim(s) objected to: ______.
   Claim(s) rejected: 1-4, 9 - 12 and 18
   Claim(s) withdrawn from consideration: ______.

3. ☐ **Allowable application** – A conference has been held. The rejection is withdrawn and a Notice of Allowance will be mailed. Prosecution on the merits remains closed. No further action is required by applicant at this time.

4. ☐ **Reopen Prosecution** – A conference has been held. The rejection is withdrawn and a new Office action will be mailed. No further action is required by applicant at this time.

All participants:

(1) John Breene, SPE. [signature: John E. Breene] (3) Cam Truong, Examiner.

(2) Joe Dixon, USPTO. (4)______.

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APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.

EXAMINER	
ART UNIT	PAPER
	20060815

DATE MAILED:

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

The Panel Decision confirmed that 102 rejection for [illegible] is ~~withdrawn from consideration~~ of the Final Rejection mailed on 4/6/2006.

Cam Y Truong
Primary Examiner
Art Unit: 2162

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of	:	
V. Castelli, et al	:	Group Art No.: 2172
Serial No. 09/237,646	:	Examiner: C. Truong
Filed: January 26, 1999	:	for IBM Corporation Anne Vachon Dougherty 3173 Cedar Road Yorktown Heights, NY 10598
Title: METHOD AND APPARATUS FOR SIMILARITY RETRIEVAL FROM ITERATIVE		

DECLARATION OF PRIOR INVENTION IN THE UNITED STATES TO OVERCOME CITED PATENT OR PUBLICATION (37 CFR 1.131)

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

1. This declaration is to establish completion of the invention in this application in the United States at a date prior to March 16, 1998, which is the earliest effective date of the U. S. Patent No. 6,298,342, of Graefe, et al entitled "Electronic Database Operations For Perspective Transformations on Relational Tables Using Pivot and Unpivot Columns" which was cited by the Examiner in the prosecution of the above-identified patent application.

2. The people making this declaration are Vittorio Castelli, Chung-Sheng Li, and John R. Smith, the original joint inventors, who are the present applicants for the pending patent application.

3. To establish the date of completion of the invention of this application, the following attached document is submitted as evidence:

the invention disclosure submission form.

From this document, it can be seen that the invention in this application was made at least by the date March 16, 1998, which is a date earlier than the effective date of the cited reference.

4. As a person signing below:

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of inventor: Vittorio Castelli

Inventor's signature Vittorio Castelli

Date 2/11/2002 Country of citizenship Italy

Residence 55 North Broadway, #2-17, White Plains, NY 10601

Post Office Address same as above

Full name of inventor: Chung-Sheng Li

Inventor's signature

Date 02/05/2002 Country of citizenship U.S.A.

Residence 50 Croton Ave., Apt. 2C, Ossining, NY 10532

Post Office Address same as above

Full name of inventor: John R. Smith

Inventor's signature John R. Smith

Date 02/05/2002 Country of citizenship U.S.A.

Residence 40 Farrell Street, New Hyde Park, NY 11040

Post Office Address same as above

IBM Confidential

Invention Disclosure

Disclosure No.	FOR USE BY PATENT OPERATIONS Patent Attorney	Where & When Received (Time Stamp)
Y0898-0009		
Inventor	Functional Code	

Full Name(s) of Inventor(s)	Userid/Node	Emp. Serial	Div/Dept	Bldg/Flr	Location	Tel. Num.
Chung-Sheng Li	csli@watson	397997	22/9AU	730/H2-B52	Hawth.	863-6661
Vittorio Castelli	vittorio@watson	707255	22/9AU	730/H2-J24	Hawth.	863-7665
John R. Smith	jrsmith@watson	994145	22/9AU	730/H2-D25	Hawth.	863-7320

Title of Invention

S-STIR: Similarity Search Through Iterative Refinement

Problem Solved by This Invention (summary)

Similarity retrieval of images based on texture and color features has generated a lot of interests recently. Most of these similarity retrievals are based on the computation of the Euclidean distance between the target feature vector and the feature vectors in the database. Euclidean distance, however, does not necessarily reflect either relative similarity required by the user. In this paper, a method based on nonlinear multidimensional scaling is proposed to provide a mechanism for the user to dynamically adjust the similarity measure. The results show that a significant improvement on the precision versus recall curve has been achieved.

BACKGROUND INFORMATION

(a) To what ☑ IBM project, ☐ Proposal, ☐ or Product, ☑ or government contract is this invention related? MMP MCCL-101
(b) Related and background publication: See References
(c) Keywords for database search for related work: Invention Disclosure
(d) Critical Date:
(e) Suggested TDC: Annex Jhingran

INVENTOR ON INTERNATIONAL ASSIGNMENT: Is any inventor of this disclosure in this country on assignment from another country?
☑ YES, ☐ No. If 'Yes', see Instruction #5.

Problem solved by this invention

Recent methods for retrieving images and videos by content from large archives utilize feature descriptors and feature comparison metrics in order to index the visual information. Examples of such content-based retrieval

WITNESSING: The two witnesses whose signatures appear below have read and understood this entire invention disclosure	DISCLOSURE SUBMITTED BY	
Signature of Witnesses / Date	Inventor's Signature / Date	Inventor's Signature / Date
12/18/97	12/18/97	
Signature of Witnesses / Date	Inventor's Signature / Date	Inventor's Signature / Date
	12/18/97	
	Inventor's Signature / Date	Inventor's Signature / Date
	12/18/97	
	Inventor's Signature / Date	Inventor's Signature / Date

systems include the IBM Query by Image Content (QBIC) system [4], the Virage visual information retrieval system [1], the MIT Photobook [7], the Alexandria project at UCSB [6, 2], and the IBM/NASA Satellite Image Retrieval System [5].

In these systems, the feature comparison between the search target and those feature vectors stored in the database is typically based upon a simple fixed metric, such as the Euclidean distance or the quadratic distance [4, 8]. While these simple metrics may minimise the computational requirements for feature comparison, they typically do not correspond well to human perceptual distance nor do they have the capabilities to adapt to the changing environment commonly arising in various scientific applications:

- Retrieve those Synthetic Aperture Radar (SAR) Satellite images and identify those regions in the images with similar ice type (can be recognized through texture features) to the search target,
- Retrieve those one-meter resolution satellite images and identify those regions in the images with similar crop type (can be recognized through spectral features) to the search target,
- Retrieve those LANDSAT Thematic Mapper (TM) satellite images and identify those regions in the images with similar terrain type (can be recognized through a combination of spectral and texture features) to the search target.

Consequently, each image in the three scenarios described above usually has applications in more than one domains.

In order to improve the results from feature comparison, The VisualSEEk project at Columbia University [8] and the Alexandria project [6, 2] have developed linear transformations of texture feature spaces. Image database allowing relevance feedback has also been investigated previously, for example, in PicHunter [3]. In PicHunter, the history of user selection is used to construct system's estimate of the user's goal image. A Bayesian learning based on probabilistic model of the user behavior is combined with user selection to estimate the probability of each image in the database. All of these methods definitely provide some improvement in image retrieval performance. However, these systems and their use of fixed transforms do not model the user and retrieval process sufficiently. Human perception is highly subjective and dependent on viewing conditions, context, and the corresponding retrieval task. The feature comparison should adapt to these variables.

Description of this invention

In this invention, we disclose an algorithm to enable the revision of feature and metric transformations based upon the interaction with the user in the retrieval process. This algorithm is based upon nonlinear multidimensional scaling (MDS) that refines the feature space based upon the user's evaluation of the retrieval results. In this system, the linear transform of the features is modified by the user's feedback. Furthermore, a deepest gradient recent process is developed to enable fast convergence of the matrix, which makes the method suited to the interactive query environment.

WITNESSES: The two witnesses whose signatures appear below have read and understand this entire invention disclosure	DISCLOSURE SUBMITTED BY	
Signature of Witnesses — Date	Inventor's Signature — Date	Inventor's Signature — Date
[signature] 12/18/97	[signature] 12/18/97	Inventor's Signature — Date
Signature of Witnesses — Date	[signature] 12/18/97	Inventor's Signature — Date
[signature]	Inventor's Signature — Date	Inventor's Signature — Date

The organization of this paper is as follows: Section 2 gives a preliminary concept of image and feature database. The proposed algorithm is described in detail in Section 3. Section 4 discusses the implementation and experiments. A brief summary is given in Section 5.

1 Preliminary

We assume that an image database consists of a set of N feature vectors. Each feature vector has n dimensions. The feature vectors potentially represent a combination of color, texture and shape information.

A query is started by presenting a query feature vector to the system. Consider that the feature vector may correspond to a particular query image, region or object. Initially, the K best matches are retrieved using a Euclidean metric. For two n-dimensional feature vectors u and v, where $\mathbf{u} = [u_1, ..., u_n]^T$ and $\mathbf{v} = [v_1, ..., v_n]^T$, the Euclidean distance between these vectors is defined as:

$$D(\mathbf{u}, \mathbf{v}) = [(\mathbf{u} - \mathbf{v})^T(\mathbf{u} - \mathbf{v})]^{1/2} = \sqrt{\sum_{i=1}^{n}(u_i - v_i)^2} \tag{1}$$

or, in general, the L^p distance metric which is defined as

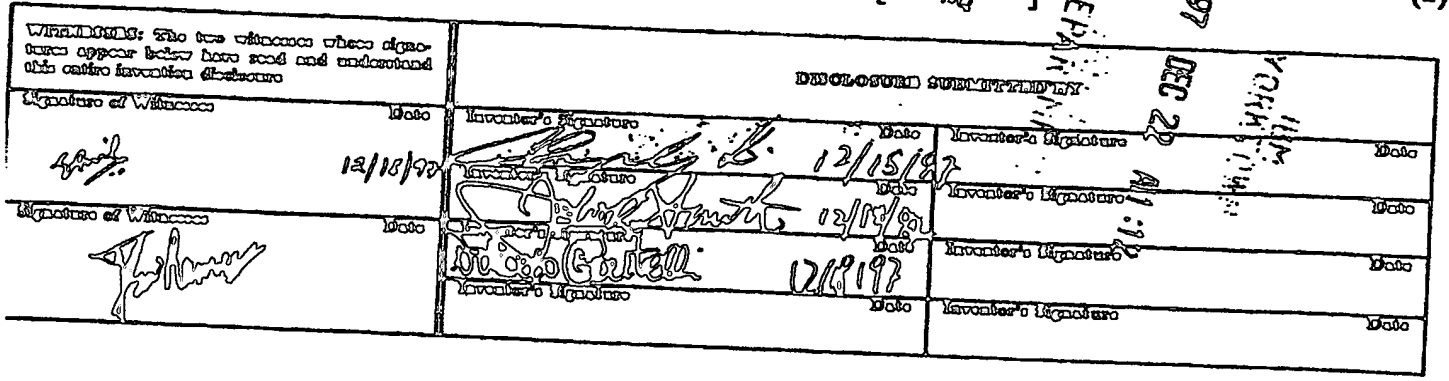
$$\begin{aligned} D_p(\mathbf{u}, \mathbf{v}) &= \left(\sum_{i=1}^{n}|u_i - v_i|^p\right)^{1/p}, \quad \forall p \in [1, \infty), \\ &= \max_i |u_i - v_i|, \qquad \text{for } p = \infty. \end{aligned}$$

The K results whose feature vectors are closest to the target feature vectors are then returned to the user for visual inspection or further processing.

The performance of the retrieval is measured in terms of precision and recall, defined below. Let X be a template, n_X be the number of matches in the database, n_Q be the requested number of results. The query returns $N_O(X, n_Q)$ of the n_X matches, where $N_O(X, n_Q) \leq \min(n_Q, n_X)$. In the following definitions, let n_Q be fixed, and let $E_X[\cdot]$ denote the expectation with respect to X.

- *Precision*, R_P: This is the proportion that the retrieved results that are relevant. For each template X, define $R_P(X, n_Q) = N_O(X, n_Q)/n_Q$. Then,

$$R_P(n_Q) = E_X[R_P(X, n_Q)] = E_X\left[\frac{N_O(X, n_Q)}{n_Q}\right]. \tag{2}$$



- *Recall,* R_A: This is the proportion of the relevant results that are retrieved. For each template X let $R_A(X,n) = N_C(X,n)/\min(n_X,n)$, the proportion of correct results in a retrieved set of size n. Then ,

$$R_A(n_Q) = \mathbf{E}_X[R_A(X,n_Q)] = \mathbf{E}_X\left[\frac{N_C(X,n_Q)}{\min(n_X,n_Q)}\right]. \tag{3}$$

Both $R_B(n_Q)$ and $R_A(n_Q)$ are estimated in the experiments by sample averages, and precision versus recall plots for each template X are obtained by varying n outside the range $[0,n_X]$ where $R_B = R_A$.

2 PROPOSED METHOD

In this section, we will first outline the nonlinear multidimensional scaling technique that is used in the proposed algorithm, and then outline the iterative refinement procedure.

2.1 Nonlinear Multidimensional Scaling

The goal of the iterative refinement process is to discover the best transformation such that the set of vectors in the desired class has minimum separation while the distance between those vectors in different classes is preserved or maximized.

This method is based on the multidimensional scaling method proposed by Webb [9]. The objective is to discover a transformation to transform all of the $\mathbf{x}_i$'s in an n-dimensional vector space $\mathcal{X}$ to $\mathbf{y}_i$'s in an m-dimensional vector space $\mathcal{Y}$:

$$\mathbf{y}_i = \mathbf{W}^*\phi(\mathbf{x}_i) \tag{4}$$

such that the following cost function

$$J = (1-\lambda)J_{se} + \lambda J_{sp} \tag{5}$$

is minimized. In this function, J_{se} is a class separability criterion, and J_{sp} is a structure preserving criterion. where $\mathbf{W}$ is an $l \times m$ matrix, and $\phi(\mathbf{x}_i)$ is a radial basis function where the i^{th} component $(i = 1,..,l)$ is defined as

$$\phi_i(\mathbf{x}) = exp\left(-\frac{|\mathbf{x}-\mathbf{c}_i|}{h^2}\right) \tag{6}$$

The parameter h^2 is a *bandwidth* term where larger value gives rise to a smaller bandwidth.

The class separability sums up the intraclass distance for all the pairs of vectors defined as below:

$$J_{se} = \sum_i \sum_j \delta(\omega_i,\omega_j)\alpha_{ij}q_{ij}^2 \tag{7}$$

where ω_i and ω_j are the class labels of vector $\mathbf{x}_i$ and $\mathbf{x}_j$, and

$$q_{ij} = |\mathbf{f}(\mathbf{x}_i) - \mathbf{f}(\mathbf{x}_j)| = |\mathbf{W}^*(\phi(\mathbf{x}_i) - \phi(\mathbf{x}_j))|, \tag{8}$$

The function $\delta(\omega_i, \omega_j)$ is defined as below:

$$\delta(\omega_i, \omega_j) = \begin{cases} 1, for \ \ \omega_i = \omega_j \\ 0, for \ \ \omega_i \neq \omega_j, \end{cases} \tag{9}$$

α_{ij}'s are positive weights, defined as

$$\alpha_{ij} = \frac{1/d_{ij}(\mathbf{X})}{\sum_i \sum_j (1/d_{ij}(\mathbf{X}))} \tag{10}$$

where $d_{ij}(\mathbf{X})$ is the Euclidean distance between $\mathbf{x}_i$ and $\mathbf{x}_j$:

$$d_{ij}(\mathbf{X}) = |\mathbf{x}_i - \mathbf{x}_j| \tag{11}$$

The structure preserving criterion is defined as below

$$J_{sp} = \sum_i \sum_j \alpha_{ij} (q_{ij} - d_{ij}(\mathbf{X}))^2 \tag{12}$$

The vectors $\mathbf{c}_i$ can be obtained from applying clustering algorithms such as K-means, Kohonen self-organization map or Tree-Structured Vector Quantizer (TSVQ) to generate l clusters from the dataset. In this paper, TSVQ is assumed due to its relative efficiency and accuracy as compared to other algorithms.

It has been shown [9] that the optimal solution $\mathbf{W}$ to Eq. 5 is the solution to the following equation:

$$\mathbf{AW} = \mathbf{D(V)V} \tag{13}$$

where

$$\mathbf{A} = \sum_i \sum_j \alpha_{ij} [(1-\lambda)\delta(\omega_i, \omega_j) + \lambda](\phi_i - \phi_j)(\phi_i - \phi_j)^* \tag{14}$$

and

$$\mathbf{D(V)} = \sum_i \sum_j c_{ij}(\mathbf{V})(\phi_i - \phi_j)(\phi_i - \phi_j)^* \tag{15}$$

$$c_{ij}(\mathbf{V}) = \begin{cases} \alpha_{ij} d_{ij}(\mathbf{X})/q_{ij}(\mathbf{V}) & (i,j) \in S_+ \\ 0 & (i,j) \in S_0 \end{cases} \tag{16}$$

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Note that S_+ correspond to a set consisting of (i,j)'s which result in a $q_{ij}(V)$ greater than zero. On the other hand, S_0 correspond to the set which contains all the (i,j)'s that result in $q_{ij}(V) = 0$.

The minimization of J will minimize the intraclass distance in the transformed space, while preserving the structure of the feature vectors. In many cases, the structure of individual feature vector can be replaced by the structure of individual cluster. The structure preserving term is essential in this framework. Without this term, a trivial solution $W = 0$ will be able to minimize J_{oo}.

2.2 S-STIR: Similarity Search Through Iterative Refinement

The basic idea of iterative refinement is that the user selects L_1 of the K matches that are most similar to the desired match and reissues the query. Based upon this feedback, the linear or nonlinear transform matrix is modified to better approximate the user's evaluation of similarity. Then, a second set of matches are found and is returned to the user. The user selects the L_2 best matches and again reissues the query. This process is repeated until either the result set converges, or the user stops the process.

If the set of the feature vectors selected by the user up to step $(i-1)$ is denoted as X_{i-1}, then

$$X_i = X_{i-1} \cup U_i \tag{17}$$

where U_i is the set of feature vectors selected during step i.

The vectors that are NOT selected up to step $i-1$ is Y_{i-1}, then

$$Y_i = Y_{i-1} \cup V_i \tag{18}$$

where V_i is the set of feature vectors rejected during step i.

S-STIR Algorithm The proposed algorithm for iterative refinement through nonlinear multidimensional scaling is as follows:

1. Performing similarity search on a feature vector, v, retrieving the K most similar results in the feature space. The similarity between v and u is measured by Eq. 1. Set $i = 1$.
2. Initialize X_1 and U_1 to those vectors which are consider to be similar. Also initialize Y_1 and V_1 to those vectors that are not considered to be similar. If the number of vectors is less than a prescribed threshold, set $K = K + K_{inc}$, where K_{inc} is a fixed increment. Return to step 1.
3. Perform the multidimensional scaling described earlier in the previous subsection based on two classes of vectors: X_i and Y_i where X_i include all the vectors that are considered similar, while Y_i include all the vectors that are considered to be no similar (or irrelevant). Consequently, the class label for X_i is 1, while the class label for Y_i is 2. The resulting W optimize the objective cost function J, as defined in Eq. 5.

4. Perform similarity search in the scaled feature space. The similarity measure between two vectors in the new space is measured by $|W^*(\phi(u) - \phi(v))|$. The results are categorized to similar (or relevant) and dissimilar (or irrelevant). Assuming that U_i and V_i are the sets that include those similar and dissimilar vectors, respectively.

5. Update X_i and Y_i as follows

$$X_i = X_{i-1} \cup U_i, \tag{19}$$

$$Y_i = Y_{i-1} \cup V_i. \tag{20}$$

if the difference between X_i and X_{i-1} is less than a prescribed threshold, a equilibrium has been reached and exit.

6. set $i = i + 1$, and return to step 3.

Note that there are a number of possible strategies to handle relevance feedback. The approach described in the algorithm treat all the feature vectors that are relevant equally important. Nevertheless, it is also possible to differentiate vectors during each iteration with different different weights (a_{ij} in Eq. 12 and Eq. 7).

3 IMPLEMENTATION AND EXPERIMENTS

The feature vector used in the database has 21 dimensions, consisting of spatial texture features such as fractal dimension, coocurrence-based texture features, spatial gray level difference-based texture features, coarseness, skew, dispersion, and Moran circular correlation. The feature database is generated as follows: We generate 32 random cuts of size 32×32 from each of the 37 satellite images, each of which consist of homogeneous image regions. A 21-dimensional texture feature is then extracted from each random cut, resulting in a database consisting a total of 1184 feature vectors. For each query, one of the random cuts from an image is used to retrieve the K most similar random cuts. The retrieved result is considered to be a hit if the the retrieved random cut belongs to the same image as the original random cut. Note that the precision and recall values given in this section are all average values, using Eq. 2 and Eq. 3. Figures 3 and 3 show examples of mountain, woods, forests, and suburban areas used in the 37 benchmark images.

To test the algorithm, we retrieve the first K (K varies from 64 to 256) feature vectors as samples and assign class labels. Note that only two feature classes will be covered if K is equal to 64. The iterative refinement algorithm outlined in the previous section is then applied to the retrieved feature vectors together with its feature class. The resulting W is applied in conjunction with the radial basis function defined in the previous section to transform all the feature vectors in the database. A nearest neighbor search is then applied to determine the resulting precision and recall values.

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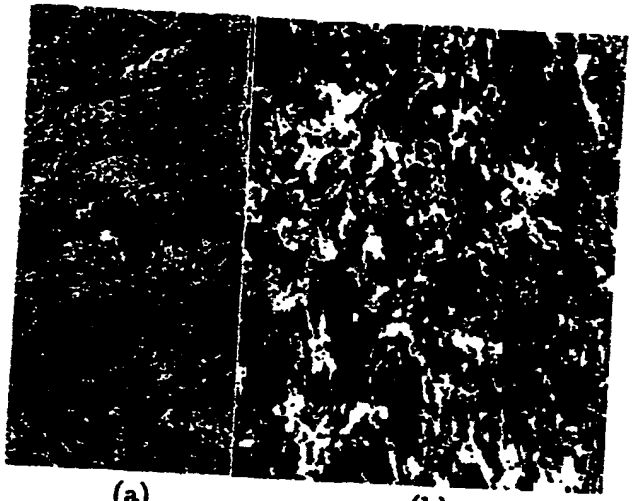

Figure 1: Satellite images of (a) mountain (b) mixed area.

Figure 3 shows the precesion versus recall for a given benchmark image before and after the S-STIR algorithm is applied. In this case, the sample size is selected to be 256, the number of radial basis functions is chosen to be 20 (thus requiring the clustering function TSVQ to generate 20 clusters from 256 vectors), and the final feature vector space has 10 dimensions. The parameter h is set at 3.16 throughout the experiment [9]. It is quite apparent that S-STIR algorithm produced a significant improvement on the precision for a given recall, and vice versa. The improvement is bigger for larger recall (or smaller precision).

To observe the impact from the parameter λ, we vary λ from 0.2 to 0.8. Smaller λ implies less emphasis on J_{ep} and more emphasis on J_{ee}, resulting in better class separability (See Eq. 5). This is evident from Fig. 4, as lower λ results in better precision versus recall curve.

Larger initial sample size is important to the S-STIR algorithm, as it requires a better *global view* of the entire database to determine the transformation. Figure 5 shows that the precision versus recall performance dramatically deteriorates as the sample size is reduced from 256 to 64. Sampling techniques of the space can be applied and may produce a better *training set* for the S-STIR algorithm. This, however, is beyond the scope of this paper.

The number of radial basis function, and thus the number of clusters needed to be generated from the TSVQ clustering algorithm, also has an impact on the performance. As shown in Fig. 6, a point is reached when

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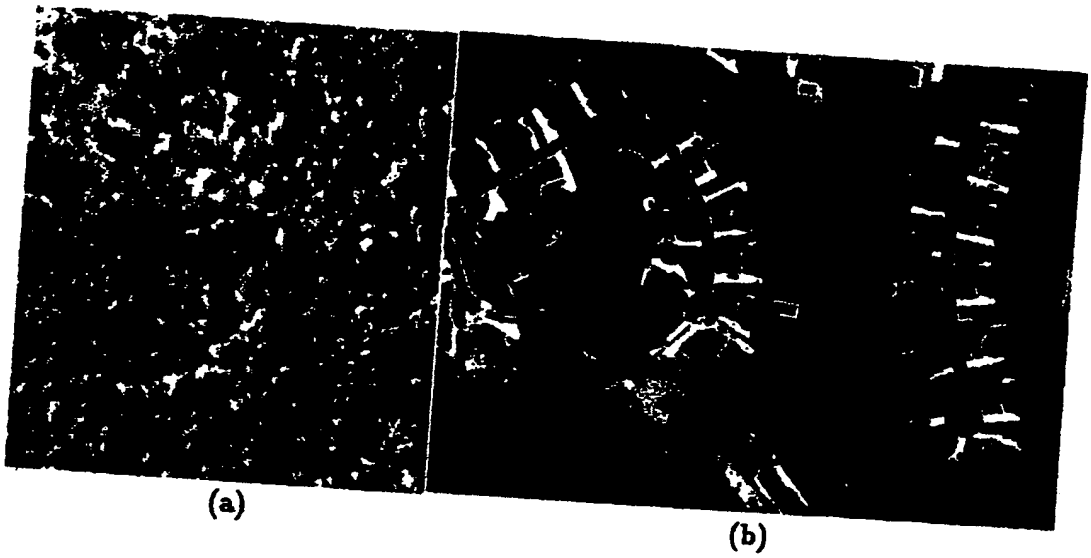

Figure 2: Satellite images of (a) forests (b) suburbs.

additional clusters will only fragmented the feature space and do not really help to produce a good decomposition of the original vector space.

The additional bonus of using the nonlinear multi-dimensional scaling technique is the reduction of dimensionality [2]. As shown in Fig. 7, the number of dimensions that are required for clean separation between the desirable and undesirable results is less than 5. Consequently, the precision versus recall curve are space fairly closely with respect to each other when the final number of dimensions is varied from 5 to 15.

4 SUMMARY

Similarity measure has been one of the critical issues for successful content-based retrieval. Simple quadratic forms of distance is inadequate as it does not necessary correspond to perceived similarity nor is it adaptive to different applications.

In this paper, we propose an iterative refinement algorithm for content-based retrieval of images based on low-level features such as textures, color histograms, and shapes that can be describe by feature vectors. This technique

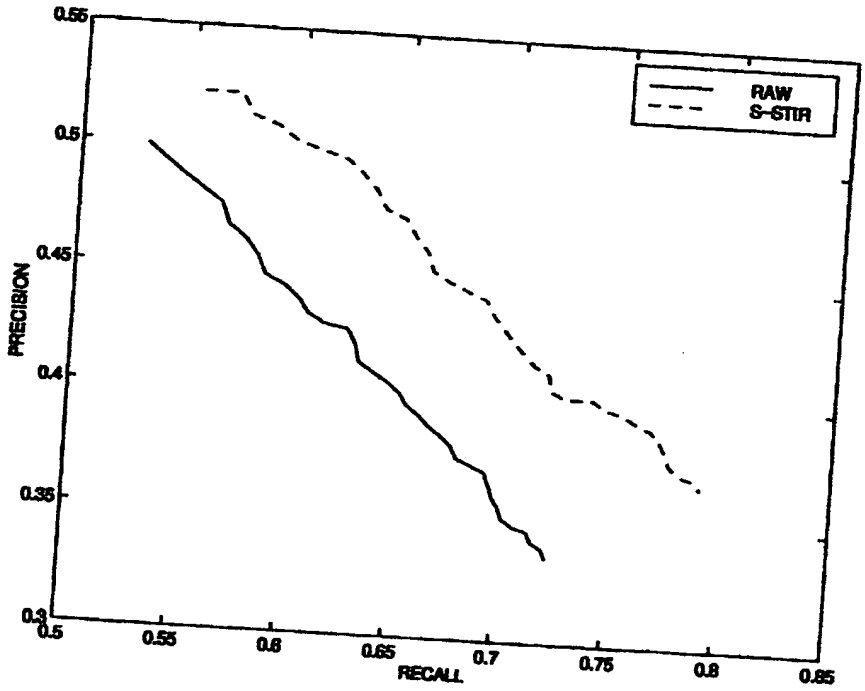

Figure 3: Comparison of precision versus recall for raw feature vector and feature vectors transformed by S-STIR algorithm.

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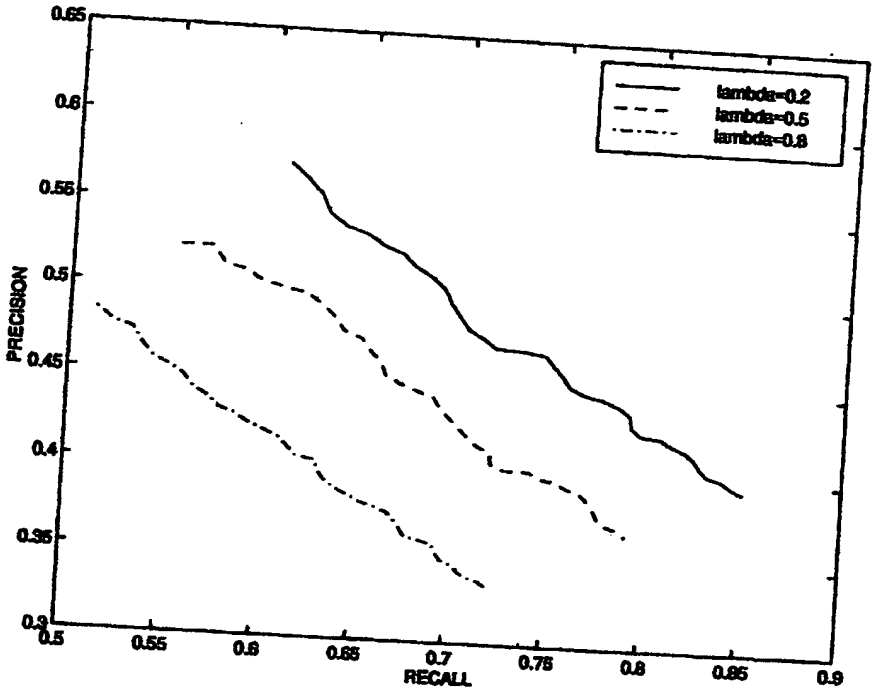

Figure 4: Effect on the precision versus recall for different values of λ.

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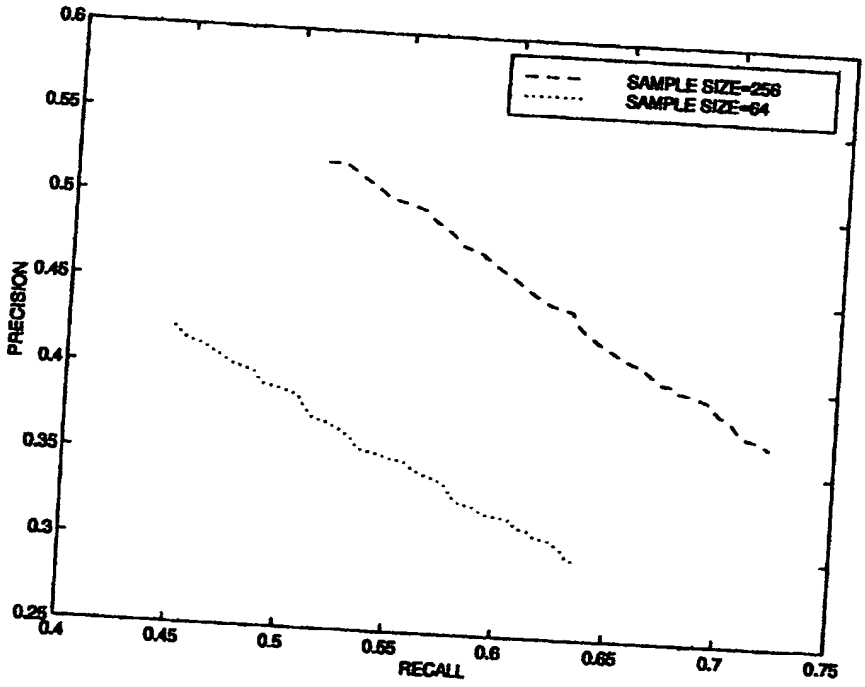

Figure 5: Effect on the precision versus recall for different values of sample size.

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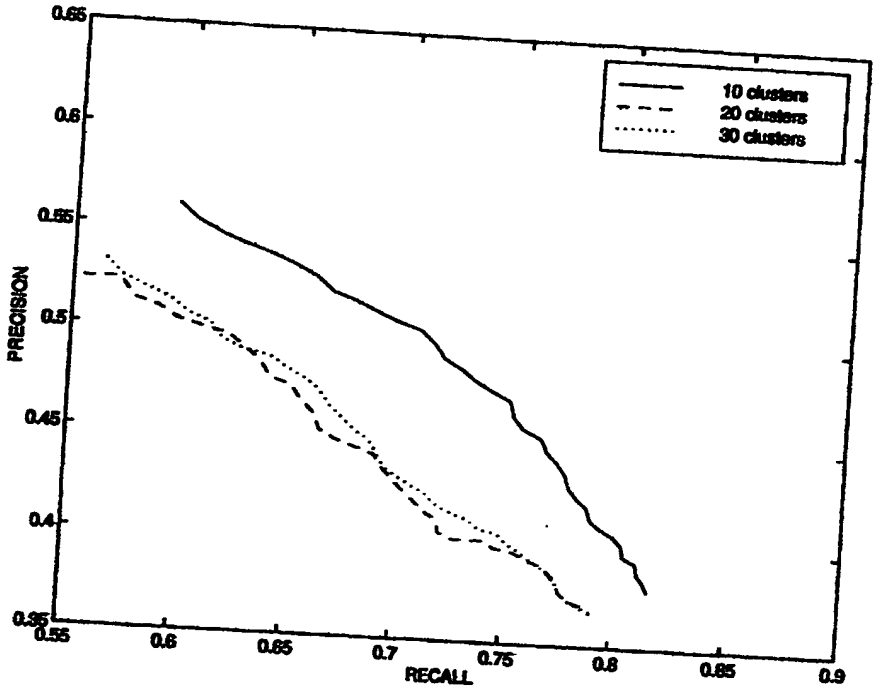

Figure 6: Effect on the precision versus recall for different number of clusters.

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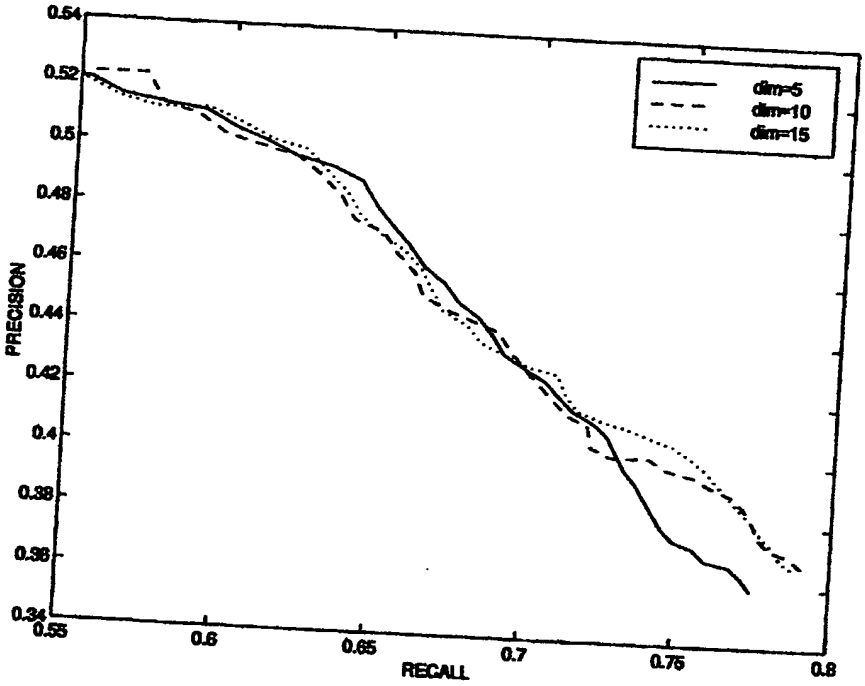

Figure 7: Effect on the precision versus recall for different values of final dimensionality.

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adjusts the original feature space to the new application by performing nonlinear multidimensional scaling. Consequently, the transformed distance of those feature vectors which are considered to be similar is minimized in the new feature space. Meanwhile, the distance among clusters are maintained.

The major concern of using MDS for iterative refinement is that it will interfere with multidimensional indexing techniques such as R-tree. Existing R-tree indices are all pre-extracted and cannot dynamically adapt to the *warped* feature space each time a user make some labeling of the retrieved results. Consequently, efficient retrieval feature vectors from a large database becomes a serious issue again.

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Alternatives

Potential Use

Potential applications include:

1. *Environmental epidemiology*: retrieve locations of houses which are vulnerable to epidemic diseases such as Hantavirus and Denge fever based on a combination of environmental factors (e.g. isolated houses that are near bushes or wetlands), and weather patterns (e.g. a wet summer followed by a dry summer).
2. *Precision farming*: retrieve locations of cauliflower crop developments that are exposed to clubroot, which is a soil-borne disease that infects cauliflower crop. Cauliflower and clubroot are recognized spectral signature, and exposure results from their spatial and temporal proximity.
3. *Medical image diagnosis*: retrieve all MRI images of brains that have tumors located within the hypothalamus. The tumors are characterized by shape and texture, and the hypothalamus is characterized by shape and spatial location within the brain.
4. *Real estate marketing*: retrieve all houses that are near a lake (color and texture), have a wooded yard (texture) and are within 100 miles of skiing (mountains are also given by texture).
5. *Interior design*: retrieve all images of patterned carpets which consist of a specific spatial arrangement of color and texture primitives.

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RELATED PROCEEDINGS APPENDIX

There are no related proceedings.